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MICHIGAN Department of Education

Algebra

The expectations in the area of *Algebra* are perhaps the most ambitious of those in any strand. This document calls for a substantial emphasis on algebra in the middle grades, and assumes a very strong foundation in number concepts and operations as the basis for that algebra emphasis. With most of the major conceptual and computational work in number well underway and nearly complete by the end of sixth grade, an emphasis on algebra is possible.

The *Algebra* expectations have been grouped into three categories:

- Patterns, relations, functions and change (PA)
- Representation (RP)
- Formulas, expressions, equations, and inequalities (FO)

The expectations included here are intended to enable all students to have a solid grounding in the fundamental areas of algebra, including functions and the use of algebraic symbols and tools, by the end of the eighth grade. As in all other strands, students will be proficient when they have not only procedural fluency with certain techniques, but also a strong conceptual base for understanding the key ideas of algebra. Early work in number, particularly understanding of number properties and the operations' relationships with one another, is central to understanding algebra in a more formal way. Likewise, emphasis on number patterns can provide a useful basis on which to build the concepts of function. (The expectations from *Number and Operations* are indicated in gray text in their respective *Algebra* categories).

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Patterns, Relations, Functions, and Change

Patterns, Relations, Functions, and Change

K	1	2	3	4	5	6	7	8
N.ME.00.02 Use one-to-one correspondence to compare and order sets of objects to 30 using such phrases as "same number","more than", or""less than"; use counting and matching.	**N.ME.01.01** Count to 110 by 1s, 2s, 5s, and 10s, starting from any number in the sequence; count to 500 by 100s and 10s; use ordinals to identify position in a sequence, e.g., 1st, 2nd, 3rd.	**N.ME.02.01** Count to 1000 by 1s, 10s and 100s starting from any number in the sequence. **N.ME.02.03** Compare and order numbers to 1000; use the symbols > and <.	**N.ME.03.04** Count orally by 6s, 7s, 8s and 9s, starting with 0, making the connection between repeated addition and multiplication. **N.ME.03.05** Know that even numbers end in 0, 2, 4, 6,or 8; name a whole number quantity that can be shared in two equal groups or grouped into pairs with no remainders; recognize even numbers as multiples of 2. Know that odd numbers end in 1, 3, 5, 7, or 9, and work with patterns involving even and odd numbers.	**N.ME.04.05** List the first ten multiples of a given one-digit whole number; determine if a whole number is a multiple of a given one-digit whole number, and if a one-digit number is a factor of a given whole number.	**N.ME.05.23** Express ratios in several ways, e.g., "3 cups to 5 people; 3 : 5; $\frac{3}{5}$" ; recognize and find equivalent ratios.	**N.ME.06.11** Find equivalent ratios by scaling up or scaling down. **A.PA.06.01** Solve applied problems involving rates, including speed, e.g., if a car is going 50 mph, how far will it go in $3\frac{1}{2}$ hours? **A.PA.06.09** Graph and write equations for linear functions of the form y = mx and solve related problems; e.g., given n chairs, the "leg function" is f(n) = 4n; if you have 5 chairs, how many legs?; if you have 12 legs, how many chairs?	**A.PA.07.06** Calculate the slope from the graph of a linear function as the ratio of "rise/run" for a pair of points on the graph, and express the answer as a fraction and a decimal; understand that linear functions have slope that is a constant rate of change. **A.PA.07.07** Represent linear functions in the form y = x + b, y = mx, and y = mx + b, and graph, interpreting slope and y-intercept. **A.PA.07.05** Understand and use directly proportional relationships of the form y = mx, and distinguish from linear relationships of the form y = mx + b, b non-zero; understand that in a directly proportional relationship between two quantities one quantity is a constant multiple of the other quantity. **A.PA.07.01** Recognize when information given in a table, graph or formula suggests a proportional or linear relationship. **A.PA.07.03** Given a directly proportional or linear situation, graph and interpret the slope and intercept(s) in terms of the original situation; evaluate y = kx for specific x values, given k, e.g., weight vs. volume of water, base cost plus cost per unit.	**A.PA.08.02** For basic functions, e.g., simple quadratics, direct and indirect variation, and population growth, describe how changes in one variable affect the others.
							A.PA.07.04 For directly proportional or linear situations, solve applied problems using graphs and equations; e.g., the heights and volume of a container with uniform cross-section; height of water in a tank being filled at a constant rate; degrees Celsius and degrees Fahrenheit; distance and time under constant speed. **A.PA.07.09** Recognize inversely proportional relationships in contextual situations; know that quantities are inversely proportional if their product is constant; e.g., the length and width of a rectangle with fixed area and that an inversely proportional relationship is of the form y = k/x where k is some non-zero number. **A.PA.07.11** Understand and use basic properties of real numbers: additive and multiplicative identities, additive and multiplicative inverses, commutativity, associativity, and the distributive property of multiplication over addition.	**A.PA.08.03** Recognize basic functions in problem contexts; e.g., area of a circle is πr^2, volume of a sphere is $\frac{4}{3}\ \pi r^3$, and represent them using tables, graphs, and formulas.

Representation

						A.RP.06.02 Plot ordered pairs of integers and use ordered pairs of integers to identify points in all four quadrants of the coordinate plane. **A.RP.06.10** Represent simple relationships between quantities using verbal descriptions, formulas or equations, tables, and graphs, e.g., perimeter-side relationship for a square, distance-time graphs, and conversions such as feet to inches. **A.RP.06.08** Understand that relationships between quantities can be suggested by graphs and tables. **N.ME.06.17** Locate negative rational numbers (including integers) on the number line; know that numbers and their negatives add to 0 and are on opposite sides and at equal distance from 0, on a number line. **N.ME.06.20** Know that the absolute value of a number is the value of the number, ignoring the sign; or is the distance of the number from 0.	**A.RP.07.10** Know that the graph of y = k/x is not a line; know its shape, and know that it crosses neither the x nor the y axis. **A.RP.07.02** Represent directly proportional and linear relationships using verbal descriptions, tables, graphs and formulas, and translate among these representations. **D.AN.07.02** Create and interpret scatter plots and use an estimated line of best fit to answer questions about the data.	**A.RP.08.05** Relate quadratic functions in factored form and vertex form to their graphs, and vice versa; note that solutions of a quadratic equation are the x-intercepts of the corresponding quadratic function. **A.RP.08.01** Identify and represent the graphs of linear functions, quadratic functions, and other simple functions including inverse functions; y = k/x, cubics ($y = ax^3$) roots ($y = \sqrt{x}$), and exponentials ($y = a^x$, a > 0), using tables, graphs, and equations. **A.RP.08.06** Graph factorable quadratic functions, finding where the graph intersects the x-axis and the coordinates of the vertex; use words "parabola" and""roots"; include functions in vertex form and those with leading coefficient –1, e.g., $y = x^2 - 36$, $y = (x - 2)^2 - 9$; $y = -x^2$; $y = -(x - 3)^2$. **A.RP.08.04** Use the vertical line test to determine if a graph represents a function in one variable.

Formulas, Expressions, Equations, Inequalities

K	1	2	3	4	5	6	7	8
	N.MR.01.11 Understand the inverse relationship between addition and subtraction, e.g., subtraction "undoes" addition: because 3 + 5 = 8, we know that 8"– 3 = 5 and 8 – 5 = 3; recognize that some problems involving combining, "taking away," or comparing can be solved by either operation. **N.ME.01.01** Count to 110 by 1s, 2s, 5s, and 10s, starting from any number in the sequence; count to 500 by 100s and 10s; use ordinals to identify position in a sequence, e.g., 1st, 2nd, 3rd.		**N.MR.03.09** Use multiplication and division fact families to understand the inverse relationship of these two operations; e.g., because3 x 8 = 24, we know that 24 ÷ 8 = 3 or 24 ÷ 3 = 8; express a multiplication statement as an equivalent division statement.	**N.ME.04.04** Find all factors of a whole number up to 50, and list factor pairs. **N.ME.04.09** Multiply two-digit numbers by 2, 3, 4, and 5, using the distributive property, e.g., 21 x 3 = (1 + 20) x 3 = (1 x 3) + (20 x 3) = 3 + 60 = 63.	**N.MR.05.02** Relate division of whole numbers with remainders to the formula a = bq + r, e.g., 34 ÷ 5 = 6 r 4, so 5 • 6 + 4 = 34; note remainder (4) is less than the divisor (6). **N.MR.05.07** Find the prime factorization of numbers between 1 and 50, express in exponential notation, e.g., 24 = 2^3 x 3^1 and understand that every whole number can be expressed as a product of primes. **N.FL.05.14** Add and subtract fractions with unlike denominators of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 100, using the common denominator that is the product of the denominators of the 2 fractions, e.g., $\frac{3}{8} + \frac{7}{10} = \frac{(3 \times 10) + (7 \times 8)}{80} = \frac{30 + 56}{80} = \frac{86}{80}$			
N.MR.00.09 Record mathematical thinking by writing simple addition and subtraction sentences, e.g., 7 + 2 = 9 and 10 – 8 = 2.	**N.MR.01.13** Apply knowledge of fact families to solve simple open sentences for addition and subtraction, such as: n + 2 = 7 and 10 - n = 6.	**N.MR.02.08** Find missing values in open sentences, e.g., 42 + n = 57; use relationship between addition and subtraction.	**N.MR.03.12** Find solutions to open sentences, such as 7 x n = 42 or 12 ÷ n = 4, using the inverse relationship between multiplication and division.	**N.FL.04.12** Find unknowns in equations such as x ÷ 10 = 25; 125 ÷ b = 25. **N.MR.04.29** Solve for the unknown in equations such as: $\frac{1}{8}$ + x = $\frac{5}{8}$ or $\frac{3}{4}$ - y = $\frac{1}{2}$.	**N.MR.05.21** Solve for the unknown in such equations as: $\frac{1}{4}$ + x = $\frac{7}{8}$.	**A.FO.06.03** Use letters, with units, to represent quantities in a variety of contexts e.g., y lbs., k minutes, x cookies. **A.FO.06.04** Distinguish between an algebraic expression and an equation. **A.FO.06.06** Represent information given in words using algebraic expressions and equations.		**A.FO.08.07** Recognize and apply the common formulas; $(a + b)^2 = a^2 + 2ab + b^2$ $(a – b)^2 = a^2 – 2ab + b^2$ $(a + b)(a – b) = a^2 – b^2$, and represent these geometrically.
						A.FO.06.05 Use standard conventions for writing algebraic expressions, e.g., 2x + 1 means "two times x, plus 1" and 2(x + 1) means "two times the quantity (x + 1)". **A.FO.06.07** Simplify expressions of the first degree by combining like terms, and evaluate using specific values. **A.FO.06.11** Relate simple linear equations with integer coefficients to particular contexts, and solve; e.g., 3x = 8 or x + 5 = 10.	**A.FO.07.12** Add, subtract and multiply simple algebraic expressions of the first degree, e.g., (92x + 8y) – 5x + y, or – 2x (5x – 4), and justify using properties of real numbers.	**A.FO.08.08** Factor simple quadratic expressions with integer coefficients, e.g., $x^2 + 6x + 9$, $x^2 + 2x – 3$ and $x^2 – 4$; solve simple quadratic equations e.g., $x^2 = 16$ or $x^2 = 5$ (by taking square roots); $x^2 – x – 6 = 0$, x^2— $2x = 15$ (by factoring); verify solutions by evaluation. **A.FO.08.09** Solve applied problems involving simple quadratic equations.
						A.FO.06.12 Understand that adding or subtracting the same number to both sides of an equation creates a new equation that has the same solution. **A.FO.06.13** Understand that multiplying or dividing both sides of an equation by the same non-zero number creates a new equation that has the same solutions.	**A.FO.07.08** Know that the solution to a linear equation corresponds to the point at which its graph crosses the x-axis.	**A.FO.08.10** Understand that to solve the equation f(x) = g(x) means to find all values of x for which the equation is true; e.g., determine whether a given value, or values from a given set, is a solution of an equation (0 is a solution of $3x^2 + 2 = 4x + 2$, but 1 is not a solution).
						A.FO.06.14 Solve equations of the form ax + b = c, e.g., 3x + 8 = 15, by hand for positive integer coefficients less than 20, using calculators otherwise.	**A.FO.07.13** From applied situations, generate and solve linear equations of the form ax + b = c and ax + b = c x + d, and interpret solutions.	**A.FO.08.11** Solve simultaneous linear equations in two variables, by graphing, by substitution and by linear combination; estimate solutions using graphs; include examples with no solutions and infinitely many solutions. **A.FO.08.12** Solve linear inequalities in one and two variables, and graph the solution sets. **A.FO.08.13** Set up and solve applied problems involving simultaneous linear equations and linear inequalities.